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Determinants of Prolonged Stay after Coronary Artery Bypass Graft Surgery

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Abstract

The prolonged stay after cardiac surgery can significantly decrease the quality of life. Many studies have assessed the risk factors associated with length of stay but only a few have discussed the risk factors of prolonged stay after surgery. Therefore, this study is aimed to determine the risk factors affecting long term stay in hospital after CABG and to make comparison between group for each risk factors. All the risk factors were determined by Kaplan-Meier analysis. Overall, 3096 of CABG patients were discharged within less than 14 days, whereas 332 patients required prolonged (>14days) stays.

Keywords: CABG; length of stay; prolonged stay; Kaplan-Meier analysis

1. Introduction

Serious illness such as heart disease is a leading cause of death of people around the world (Mohammad *et al*., 2008). Duration of stay in the hospitals require high treatment costs. The prolonged stay after cardiac surgery can significantly decrease the quality of life and increase overall hospital costs. Many studies have assessed the risk factors associated with length of stay after surgical treatment. Li *et*

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al. (2002) expressed 70-90% of medical costs of serious diseases involving the long stay in hospital effects the economy. This fact is also agreed by Rodriguez *et al.* (2010) and Rony *et al.* (2008). Nawata *et al.* (2009) from the University of Tokyo, Japan introduced the Prospective Payment system (patients were charged a fixed fee regardless of the length of stay) in order to reduce the length of hospital stay. The study of risk factors that affect the length of stay in hospital and its impact on resource utilization are reviewed by Yaseen *et al.* (2002) and Ono *et al. (*2010). Girod *et al.* (2010) studied the improvement of the length of hospital stay 207 for free flap reconstructions of the oral cavity patients.

There are only a few have discussed the risk factors related to prolonged stay after surgery. Prediction of prolonged ICU stay due to hypertension following CABG surgery was studied by Julie *et al*., 2010. Paul *et al.* (2000) in their study found that prolonged mechanical ventilation were due to respiratory instability, advanced age, renal failure, previous CABG surgery, female gender, and stroke. Patients with complications of stroke and wound infections had the longest mean of stay after CABG surgery (Eric *et al*., 2002).

This study is aimed to :a) determine the risk factors affecting long term stay in hospital after CABG surgery, and b) make comparison between group for each risk factors. In order to do so, length of stay in hospital, age, sex, risk factors such as diabetes mellitus, hypertension, obesity, stroke and wound infection must be investigated.

2. Patients and methods

2.1. Patients

This study included 3560 patients who received Coronary Artery Bypass Graft surgery (CABG) in the treatment of a hospital in Kuala Lumpur, Malaysia for three years (2007-2010). Patient data comprised: the dates of operation and discharge from the hospital, birth, sex, type of medical operations (CABG and valve surgery and combination of both), major risk factors (diabetes melitus, hypertension and obesity) and other clinical conditions (stroke and wound infection). Patients underwent valve and combination surgery were excluded in this study.

2.2. Statistical analysis

Data analysis was performed with SPSS version 17 software (SPSS Inc., Chicago, IL, USA). Length of stay was defined as the number of days from the operation date to the date of hospital discharge. Prolonged stay was defined as patients discharged more than 14 days after CABG surgery (Yaseen *et al*., 2002). Deaths were censored in the analysis. Kaplan-Meier method was used to estimate the survival curves. Log-Rank test was used to evaluate the difference between the curves. For p-value less than 0.10, variables were identified as significant. Two independent groups of sample data were compared by Mann-Whitney U test.

2.3. Kaplan-Meier survival analysis

It is a statistical method to analyze data with the outcome variables of interest to an event occurring. Censored data occurs when the patient is lost from study or the patient withdrew the treatment (Miller, 1981).

3. Results

3.1. Univariate Analysis

Table 1 summarizes the univariate analysis of patients demographics and postoperative factors. 3428 patients underwent CABG surgery survived and were discharged from hospital. Among this cohort 492 (14.35%) were female patients and 2936 (85.65%) male patients with the average of normal stay 10.76 ± 0.15 days. The female patients stayed longer in the hospital compared to the male patients. The achieved results reported that for the average of normal stay in the hospital, patients with diabetes, hypertension, stroke and wound infection stay longer compared to normal patients with the same risk factors. This is proven by Mann-Whitney test U which all the factors (gender, age, diabetes, hypertension, obesity, stroke and wound infection) were significance (p-value < 0.05). In the context of prolonged stay in the hospital (>14 days) , patients age < 70 years, had diabetes, stroke and wound infections tend to have prolonged hospitalization than patients ≥ 70 years and without the same risk factors. The mean length of hospital stay for CABG patients were 8 days. The mean age of cardiac patients were 58.76 years and modal age was at 59 years. From Table 1, 50% of patients underwent CABG surgery stayed more than 14 days in hospital for all risk factors.

Table 1. Univariate analysis of patient demographics and postoperative factors

Variable		Number of patients (%)	Normal Stay (mean ± SD)	Prolonged stay	p-value (log-rank test)	Median	p-value (Mann-Whitney test)
Gender	Male	2936(85.65%)	10.76±0.15	27.5±1.135	0.907	21	0.040
	female	492(14.35%)	11.39±0.391	28.017±2.236		20	
Age	<70	3077(89.76%)	10.71±0.146	27.884±1.135	0.444	21	0.000
	≥70	351(10.24%)	12.13±0.481	26.109±2.186		20	
Diabetes	Yes	1823(53.18%)	11.52±0.216	28.8±1.372	0.03	22	0.000
	No	1605(46.82%)	10.09±0.169	25.638±1.445		20	
Hypertension	Yes	2835(82.70%)	10.94±0.155	27.466±1.104	0.93	21	0.000
	No	593(17.30%)	10.45±0.325	28.275±2.579		20	
Obesity	Yes	80(2.33%)	12.21±0.826	23.813±2.321	0.427	20	0.013
	No	3348(97.66%)	10.82±0.142	27.782±1.058		21	
Stroke	Yes	9(%)	26.33±5.185	27.475±1.027	0.269	30	0.000
	No	3419(99.73%)	10.81±0.139	33.833±5.51		21	
Wound Infection	Yes	189(5.51%)	24.06±1.516	35.412±2.258	0.000	28	0.000
	No	3239(94.49%)	10.08±0.104	24.122±0.987		20	

3.2. Multivariate Analysis

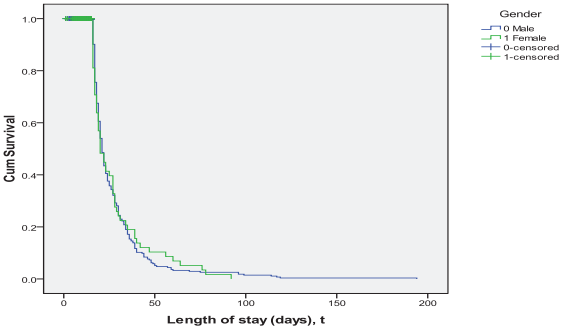
The analysis is further extended by dividing the study population according to gender categories of male and female patients (Table 2). Discussions began with a group of less than 70 years of age. Male group had the highest number of 2172 patients (74%) compared to 366 female patients who had

hypertension and the difference is almost 7 times more than women. This trend is followed for other risk factors such as diabetes 1384 male patients (47.1%) than 266 female patients. The number of male patients for risk factors of obesity, stroke and wound infection were 4 to 7 times higher than female patients. The second age group of 70 years and over, recorded the number of male patients dominated all risk factors except for stroke compared to women. In conclusion, the number of patients at the highest recorded for both age groups were male patients.

Table 2. Multivariate analysis of patient demographics and postoperative factors

Gender	Age	Hypertension		Diabetes Melitus		Obesity		Stroke		Wound Infection		Total
		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	
Male	< 70	482	2172	1270	1384	2596	58	2646	8	2526	128	2654
		16.4%	74.0%	43.3%	47.1%	88.4%	2.0%	90.1%	.3%	86.0%	4.4%	90.4%
	≥70	46	236	151	131	279	3	282	0	256	26	282
		1.6%	8.0%	5.1%	4.5%	9.5%	.1%	9.6%	.0%	8.7%	.9%	9.6%
	Total	528	2408	1421	1515	2875	61	2928	8	2782	154	2936
		18.0%	82.0%	48.4%	51.6%	97.9%	2.1%	99.7%	.3%	94.8%	5.2%	100.0%
Female	< 70	57	366	157	266	405	18	423	0	392	31	423
		11.6%	74.4%	31.9%	54.1%	82.3%	3.7%	86.0%	.0%	79.7%	6.3%	86.0%
	≥70	8	61	27	42	68	1	68	1	65	4	69
		1.6%	12.4%	5.5%	8.5%	13.8%	.2%	13.8%	.2%	13.2%	.8%	14.0%
	Total	65	427	184	308	473	19	491	1	457	35	492
		13.2%	86.8%	37.4%	62.6%	96.1%	3.9%	99.8%	.2%	92.9%	7.1%	100.0%

3.3. Kaplan -Meier Analysis



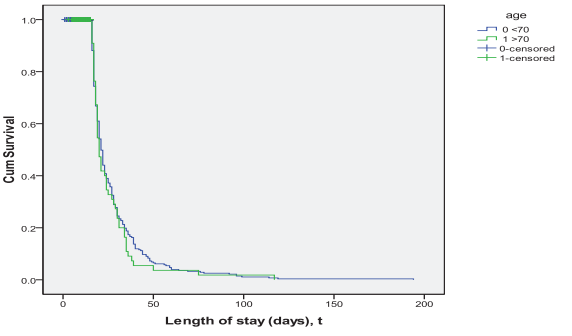
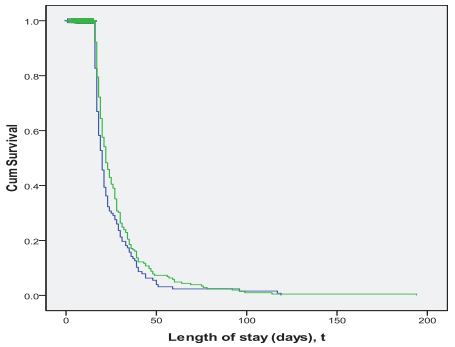


Fig 1. Survival analysis for each gender; Fig. 2. Survival analysis for two age groups



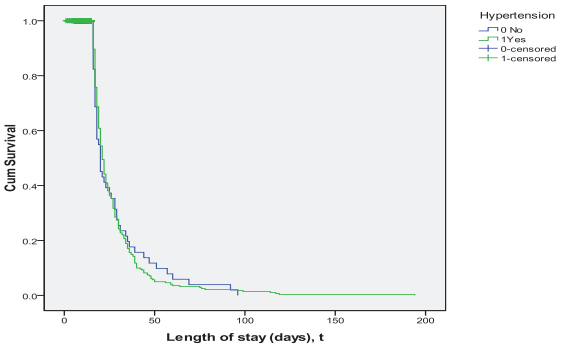


Fig 3. Survival analysis for diabetec and non-diabetic patients; Fig.4. Survival analysis for hypertensive and non-hypertensive patients.

Figure 1 shows the survival curves for both gender groups who underwent CABG surgery. It was found that there are differences in survival between the two gender groups. The survival curves for both gender were almost identical at the beginning of the study (47 days). After 47 days, the survival curve for female patients is higher than the male curve. From 96 days until the end of the study, only the survival curves for male patients can be seen. One possible reason could be there is no longer female patients who stayed in the same period. The results obtained from the log-rank test revealed no significant differences existed between the two gender groups where value of p is equal to 0.907.

The survival curves showed (figure 2) that at the beginning of the study until 39 days, the survival function for patients aged 70 years above and below were almost identical. Between 40 days and 55 days, patients with aged more than 70 years (4.8%) stayed shorter period in the hospital than patients aged less than 70 years (3.3%). There were 1 patient of aged > 70 years and 3 patients of aged < 70 years required prolonged stay more than 100 days. Log-rank test showed that the p-value is 0.444 which is greater than 0.10. This shows that there is no significant difference between the two age groups. As a conclusion, age is not a risk factor that cause patients to stay longer in the hospital.

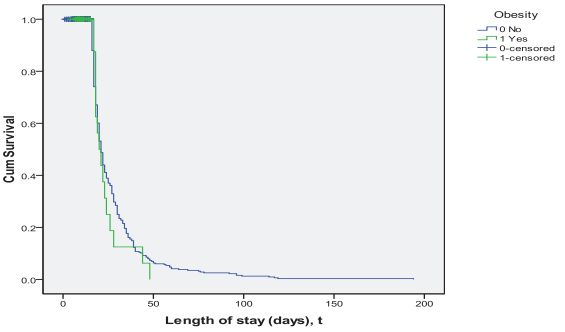
Top of Form At the beginning of the study up to 99 days (figure 3), the survival function for patients with diabetes was higher than the non-diabetic patients. This shows that the diabetic patients (61.14%) required prolonged stay than the non-diabetic patients (37.65%) . From 90 to 194 days, only 2 patients for both categories received treatment in the hospital. We can conclude that there exists a difference for prolonged stay in hospital for both groups. It was justified by log-rank test (p-value = 0.059).

Top of Form Dual plot in (figure 4) describes the prognosis for the survival of hypertensive (74.7%) and non-hypertensive (12.95%) patients. In the first 39 days of the study, the two functions were almost identical. From 40 to 194 days, a total of 32 patients with hypertension required longer period of stay in hospital. P-value (0.93) showed no significant differences in length of stay existed between the two groups. This suggests that high blood pressure is not a risk factor affecting the long period stay in hospital.

The three-year Kaplan-Meier analysis (figure 5) estimates the prolonged length of stay was 24.10% for obese patients. In the first 28 days, survival estimations for non-obese (66.87%) and obese patients (4.21%) were identical. After 28 days until day-50, it was found that the non-obese stayed in the hospital in a shorter period of time compared to obese patients. The survival curves for patients with obesity can be seen until the end of the study. This could be due to there is no longer obese patients in the hospital

during this period. P-value (0.427) verified that obese and non-obese patients did not show any significant differences for the prolonged stay in hospital.

The comparison of the prolonged stay in hospital between patients who experienced complication such as wound infection and patients without complication was significance (p-value 0.00). From beginning till the end of the study (figure 6), it was found that patients with complications (30.70%) stayed longer in hospital.



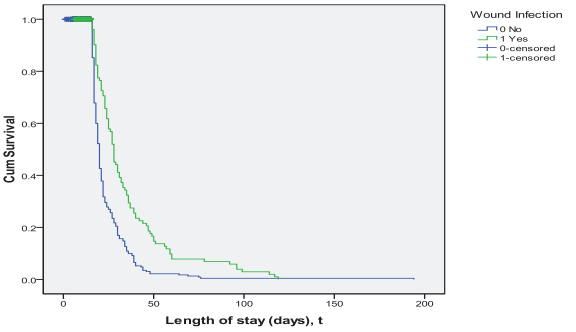


Fig 5. Survival analysis for obese and non-obese patients; Fig.6. Survival analysis for patients with and without complication (wound infection).

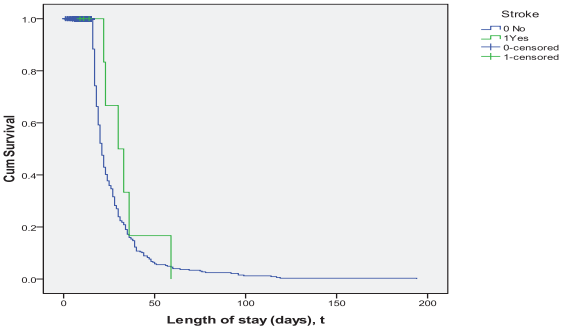


Fig 7. Survival analysis of patients with and without complication (stroke)

Survival analysis (figure 7) clearly showed that, until day-60, patients without the stroke complications required prolonged stay in hospital than patients who had a stroke after CABG surgery. However, there is no significant difference (p-value = 0.269) of length of stay between the two groups.

4. Discussion

4.1. Risk Factors for Prolonged Stay after CABG surgery

Descriptive statistics showed that 50% of male and female patients were hospitalized more than 14 days as for all the risk factors such as obesity, hypertension, diabetes and complications. From previous study, obesity was often associated with factors of stay in hospitals (Paul *et al*., 2000). Age greater than 70 years is also a common factor for longer stay in hospital (Rodriguez *et al*., 2010). This is evident from

the result of Mann Whitney U test. The average survival period of stay for comparison group of risk factors are similar to each other except for patients who had complications of wound infection.

From the analysis, it is showed that male patients with stroke were more likely to have longer hospitalization period than female patients with stroke. This result is similar to Goto *et al.* (2007). Women is found to stay longer in the hospital compared to men (Paul *et al*., 2000). Research shows that most of U.S. CABG patients stay in hospital for 5 days (Eric *et al*., 2002). This is contradict to the study conducted by researcher where most of Asian CABG patients stay in hospital for 8 days. In the preliminary univariate analysis, most of the patients stayed in the hospital for more than 14 days is more susceptible to complications.

The independent variables used in this study is the prolonged long stay in hospital of >14 days (Li *et al*., 2009), while the dependent variables studied were gender, age, hypertension, obesity, diabetes mellitus, stroke and complications of wound infection. The study found that two groups of non-diabetic and diabetic cardiac patients and patients with and without complication of wound infection had differences of prolonged hospitalization between the respective groups (p-value < 0.05).

4.2. Perspective of Future Impacts

Length of stay (LOS) factors (especially involving prolonged hospitalization) in hospital for patients undergone CABG has important roles in institution, health economic and clinical implication as it shows level of efficiency. Efficiency can be defined as the relationship between input and output system. For example, number of patients can be increased (input) due to availability number of beds (output) (Ine *et al*., 2008). This means that the hospital management need to maximize the usage of availability resources and patients do not have to wait for long periods of time to be admitted to the hospital. It is reported that 30% of patients need to wait for admission in the hospital (Rony *et al*., 2008). Therefore, time can be saved and the quality of services will be more effective. The increase of patients requires changes of quality services and management.

CABG surgery procedures involve high costs. In the economic context of health, reduction of hospital stay allows the hospital to accommodate more patients. This is a positive aspect for both parties. The hospital could generate more money to the inclusion of many patients and this could reduce their medical costs. To get the maximum returns in addition to maintaining the quality of services, the healthcare provider must have a system to structure a plan, budget and monitoring mechanism.

Quality of health should be emphasized along with the reduction of the LOS. For example, reduction of hospital stay occurred if patients experienced complications after surgery can be reduced. A physician can also make an objective clinical assessment of cardiac patients based on the findings.

4.3. Quality of Life

From the analysis, it shows that the population of male patients 2936 (85.65)% is higher as compared to female patients 492 (14.35%). This might be due to the sensitivity of female patients to health care and by frequent consultation regarding their symptoms to health experts (Mechanic., 1976). It is believed that precaution taken by female patients have prevented them from experience decline in their health. Furthermore, it shows women had their therapeutic procedures effectively. This theory is the effects of biological and social factors (Vladan et al., 2010). However, findings proven that female patients spent more time in a hospital than male patients. This is due to age factor as female patients (14%) underwent CABG at older age compared to male patients (9.6%). Older patients required more time for recovery process as compared to younger ones. Male patients (88.89%) are more likely to suffer from stroke after CABG surgery compared to female patients (11.11%). Aortic atherosclerosis increase the risk factor of

stroke (Tomoko et al., 2007). Stroke directly proportional to high cholestrol level that corresponds to quality of life incuding lifestyle, daily diet and genetic factors.

4.4. Strengths and Limitations

Researcher faced with a few constraints when conducting this research. The variables used were very limited because the patients' data were strictly protected by hospital for confidentially purposes. Survival analysis also has several problems such as the truncated data and the outcome variable is not normally distributed (Marubini, 2004). New statistical methods need to be studied to overcome this problem by adding the uncertainty in estimating the survival and the data can be summarized and shown graphically. Log-rank test was used to test the statistical difference shown only diabetes and wound infections were significantly related to the long term stay in hospital. While other factors were not significance. One possible reason would be because the sample size between the risk factors is imbalanced or there could be other factors exist that influence a more long term stay in the hospital. Therefore, the author suggests the study may be extended further by finding an appropriate form of distribution for each factor. In addition, further research can be done building the model. Duration of stay in the hospitals require high treatment costs. The result of this study will helpthe hospital to improve the quality of services and management. Comparison of survival curves for risk factors are expected to bring awareness to the community to adopt a healthy lifestyle.

5. Conclusion

All the risk factors studied influenced the hospital stay (gender, age, diabetes, hypertension, obesity, stroke and wound infection). Two independent factors such as diabetes and wound infection have been shown associated with a prolonged stay for the patients after CABG surgery compared with the patients without both symptoms. Findings proven that longer stay after cardiac surgery can significantly decrease the quality of life.

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